Air Force Research Laboratory|AFRL
Science and Technology for Tomorrow's Air and Space Force

SUCCESS STORY

AFRL DEVELOPS HIGH-EFFICIENCY MULTIJUNCTION SOLAR CELLS

As highly efficient collectors of the sun's energy, single-crystal multijunction (MJ) solar cells maximize solar panel electrical output. They also withstand the hostile environments endured throughout such operations as the National Aeronautics and Space Administration's (NASA) interplanetary space missions. These solar arrays provide nearly a 50% improvement in cell efficiency compared to the single-junction solar cells used on the earlier, Mars Pathfinder mission.

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Accomplishment

The Mars Exploration Rover (MER) program posed significant engineering and technology challenges due to many design and operational constraints, including limited available panel area, changing illumination levels and temperatures, variable shadowing and atmospheric conditions, and dust accumulation on the rovers.

AFRL worked with Spectrolab, Inc. (a Boeing subsidiary in Sylmar, California), through the Dual-Use Science and Technology (DUS&T) program to develop the triple-junction solar cells. These cells subsequently powered NASA's MER solar arrays aboard the two Mars rovers Spirit and Opportunity, sitting atop what resembled the rovers' "wings."

The ultra-triple-junction (UTJ) cells employ a three-layered structure to more effectively capture and convert solar energy into electricity. Each of the junction cells converts a different portion of the solar spectrum into electricity, greatly improving energy conversion efficiency.

Spirit and Opportunity landed on Mars in early 2004 to continue NASA's quest to explore the role of water on Mars. Once on the Martian surface, the solar panels deployed to form a total area of 1.3 square meters of UTJ solar cells that powered all spacecraft activities and instruments.

Background

The MJ solar cells used for the MER program were UTJ solar cells with a 27.5% beginning-of-life efficiency. High-efficiency solar cells provide two critical benefits to military and civil space programs. (1) By directly replacing lower-efficiency cells, they permit increases in solar array power output without increasing solar panel size or number, thereby minimizing costs in programs such as NASA's Global Positioning System effort, wherein engineers accommodated the power needs of an additional payload by switching to high-efficiency cells.

(2) By maintaining the power level of a legacy spacecraft design, these cells reduce both deployed array area and stowed volume, a critical reduction for programs required to downsize from a Titan IV launch vehicle to an evolved expendable launch vehicle, which has 33% less shroud volume.

NASA also used MJ solar cells successfully in other interplanetary missions: the Mars Global Surveyor, which monitored Martian weather patterns; the Beagle 2, which served as another Mars exploration spacecraft, and the Near Earth Asteroid Rendezvous spacecraft, which reached a distance from the sun marking the farthest travel of any solar array.

Space Vehicles
Technology Transfer

Additional Information

To receive more information about this or other activities in the Air Force Research Laboratory, contact TECH CONNECT, AFRL/XPTC, (800) 203-6451 and you will be directed to the appropriate laboratory expert. (VS-S-06-02)